Silviculture Practices Section
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SILVICULTURE NOTE 25

BOREAL PLANT COMMUNITY DIVERSITY 10 YEARS AFTER GLYPHOSATE TREATMENT: A REPORT SUMMARY

Broadcast and spot application of glyphosate at two boreal mixedwood sites in northeastern British Columbia improved white spruce growth without adversely affecting the structural and species diversity of vascular plant communities 10 and 12 years after treatment.

The glyphosate herbicide (Vision® or Roundup®) has been successfully and cost-effectively used to achieve reforestation objectives in British Columbia since its registration in Canada for forestry use in 1984. It is now the most commonly used forestry herbicide in British Columbia. However, concerns have been raised about the effects of glyphosate on structural complexity and species diversity of native plant communities. This summary presents the results of a study on response of plant communities to glyphosate site preparation at two sites located in the boreal white and black spruce (BWBS) biogeoclimatic zone. The study is one of the long-term trials established in the interior of BC in the 1980s to evaluate the effectiveness of various site preparation methods including prescribed burning and mechanical and herbicide techniques.

Study Area Descriptions

The study was conducted at the Iron Creek and Wonowon trial sites located northwest of Fort St. John on sub-hygric and mesic site series of the BWBSmw1 variant. At both sites, a mature boreal mixedwood forest was clearcut harvested in 1977 and left to regenerate naturally. Assessments in the mid-1980s indicated failed coniferous regeneration with dense vegetation regrowth (including bluejoint, fireweed, aspen, and tall shrubs) at both sites.

Methods

The entire cutblock at Iron Creek was mechanically sheared in winter 1985/86 and the resulting slash was piled in long windrows. There was minimal exposure of mineral soil. Study plots, each measuring 30 m × 40 m, were located between the windrows. Five randomly located plots were broadcast-sprayed with glyphosate at 2.5 kg ae/ha using a CO_2 pressurized backpack sprayer on August 21, 1986. Five untreated (control) plots were also selected. In spring 1987, 80 white spruce seedlings (1+0 PSB 313 container stock) were planted on each plot.

At Wonowon, study plots (also 30 m × 40 m each) were located on the unprepared cutblock and planted with 80 white spruce seedlings (2+1 bareroot transplant stock) in June 1984. On five randomly selected treatment plots, a 1 m radius circle surrounding each of the inner 48 spruce seedlings was sprayed with glyphosate at an experimental rate of 5 kg ae/ha in September 1984. Five randomly selected treatment plots were left as untreated controls.

Ten-year (Iron Creek) and 12 year (Wonowon) post-treatment vegetation sampling was carried out in July 1996. Percent cover and average top height were

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recorded for each plant species and each vegetation layer. Height and basal diameter of all surviving white spruce sample trees were measured in the autumn of 1996. Analysis of variance was used to test for differences between untreated and glyphosate-treated plots in vegetation structure, structural and species diversity (the variety of species on the site), the abundance of major shrub and herb species, and white spruce performance for each study site. Vegetation structure is the stratification of a plant community into categories based on size and physical features rather than taxonomy (e.g., trees, tall shrubs, forbs, mosses).

Results after 10 and 12 Years

Ten years following treatment, glyphosate-treated plots at Iron Creek could be distinguished from untreated plots by the patchy cover of heavily browsed hardwood stems and the larger white spruce trees (Figure 1, Table 1). As Figure 2 illustrates, glyphosate reduced the dominance of the tall shrub overstorey, and thereby increased the structural diversity of the plant community ($p = 0.03$). Plant species diversity was also slightly higher on the glyphosate-treated plots (Figure 3), because a greater variety of herb species

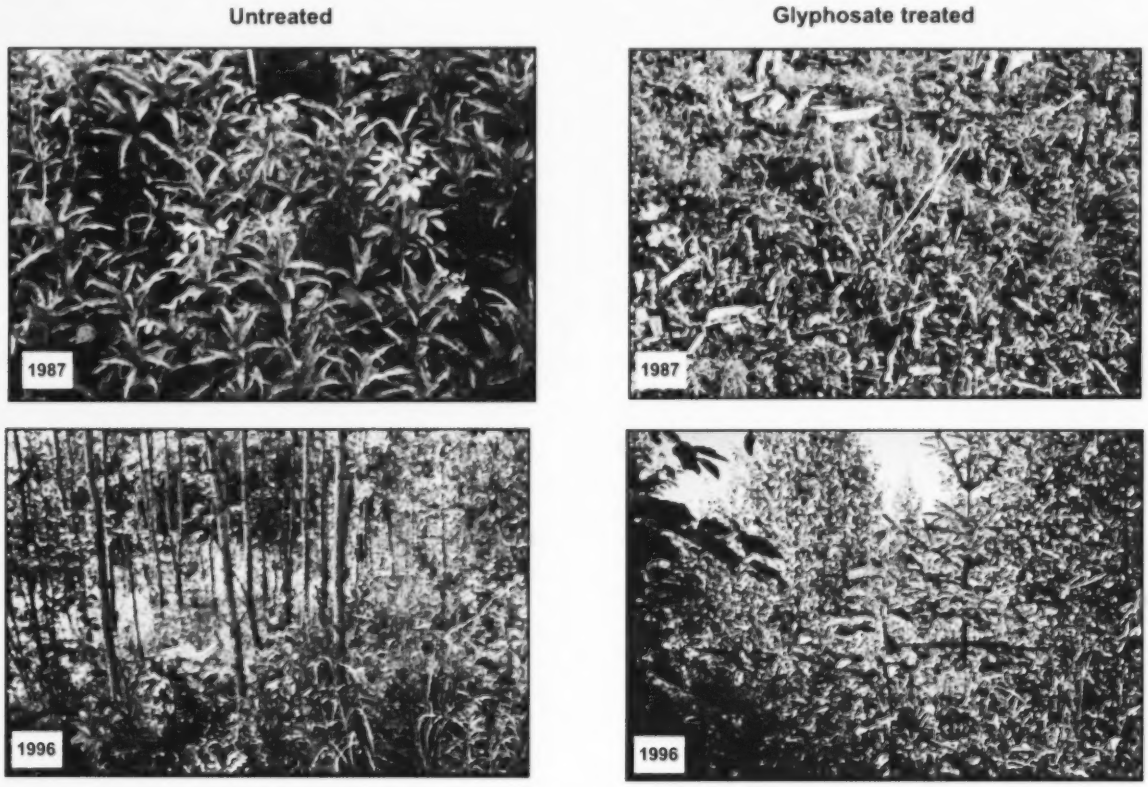

Figure 1. Untreated and glyphosate-treated plots at Iron Creek in 1987 and 1996.

Table 1. White spruce performance on untreated and glyphosate-treated plots

	Iron Creek – Broadcast sprayed			Wonowon – Spot sprayed		
White spruce growth	**Untreated**	**Glyphosate**	**p-value**	**Untreated**	**Glyphosate**	**p-value**
Total height (cm)	149	201	0.037	171	261	0.077
Basal diameter (cm)	2.3	3.4	0.009	2.6	4.2	0.046
Stem volume[a] (cm^3)	307	836	0.036	460	1757	0.048

[a] Stem vol. = $3.1416/3 \times (\text{diam.}/2)^2 \times \text{height}$

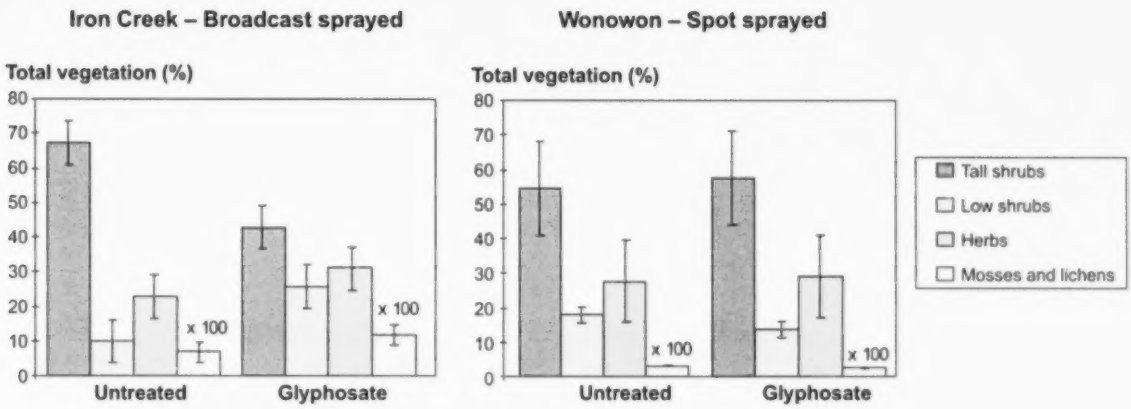

Figure 2. Vegetation structure on untreated and glyphosate-treated plots.

were present. Although total shrub cover and volume were reduced, all of the major browse (willow, aspen, balsam poplar, birch, and highbush cranberry) and berry (prickly rose, raspberry, and highbush cranberry) species were abundant 10 years after treatment. The study lacked the statistical power to detect significant reduction in the cover of any of these species.

At Wonowon, the only visible difference between the spot-sprayed and untreated plots 12 years after treatment was that planted white spruce trees were much larger on the treated plots (Figure 4, Table 1). Plant species diversity and structural diversity indices for glyphosate-treated and untreated plots were virtually identical (Figures 2 and 3, $p>0.4$) and we could not detect significant differences in the cover of any of the major plant species on the site.

Discussion

No major differences in vascular plant species composition or reduction in the richness (number of species per unit area) and diversity of plant communities were detected at the two boreal forests a decade or more after glyphosate treatment. Although site preparation with glyphosate greatly enhanced the growth of planted white spruce the deciduous tree and shrub component still dominated 10 and 12 years post-treatment. The structural diversity of the plant community was unchanged by the glyphosate treatment at Wonowon, but was increased at the Iron Creek site because vegetation was more equitably distributed among structural layers.

This study and many others across North America have shown that a single application of glyphosate does not eliminate the dominant or target plant species. These

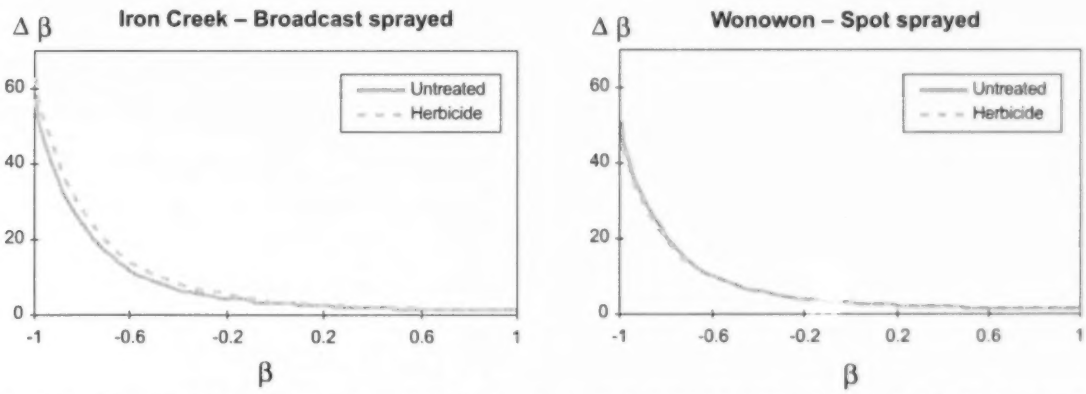

Figure 3. Diversity index profiles show that glyphosate-treated plots at Iron Creek have slightly higher species diversity than untreated plots, while at Wonowon there is no difference in species diversity (Δ_β = species richness at $\beta = -1$, Shannon's diversity index at $\beta = 0$ and Simpson's diversity index at $\beta = 1$).

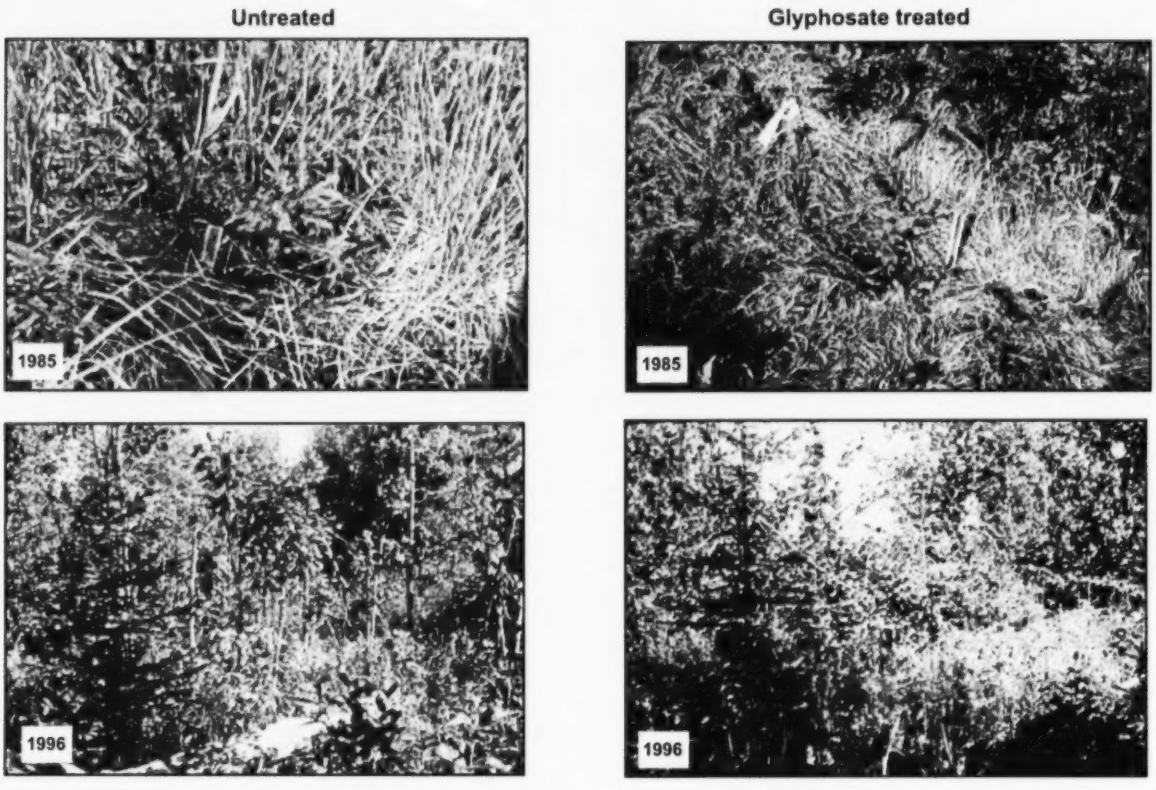

Figure 4. *Untreated and glyphosate-treated plots at Wonowon in 1985 and 1996.*

species possess a variety of regenerative mechanisms (sprouting, suckering, rapid reseeding) that enable them to recover quickly following disturbance, particularly when, as in this study, the herbicide is not uniformly applied over large areas. The effect of glyphosate on minor understorey herbs, mosses, liverworts and lichens is, however, not well known. The present study was unable to test the effect of glyphosate on rare or uncommon plant species. Although lower richness and diversity values for mosses and lichens were obtained on the glyphosate-treated plots than on the untreated plots at both Iron Creek and Wonowon, the reductions were not statistically significant. The results indicate a need for further study of glyphosate impact on non-vascular plant diversity.

Conclusion

Like all forest vegetation management tools, glyphosate has the potential to either increase or decrease plant diversity depending on how it is used. The 10 to 12 year post-treatment results at Iron Creek and Wonowon indicate that application of glyphosate to small treatment areas can increase crop tree growth without adversely affecting vascular plant community structure, richness, and diversity. The evaluation of any glyphosate treatment impact, however, should be done within the larger stand- to landscape-level context and also in conjunction with other past and future forest management activities.

The full report is available in the following paper:

Boateng, J.O., S. Haeussler, and L. Bedford. 2000. Boreal plant community diversity 10 years after glyphosate treatment. West. J. Appl. For. 15(1):15–26.

For More Information

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